Wireless Medium Access Control and CDMA, 3G, WiMax, 4G and 5G Networks

Lesson 01
Modulation

Modulation

- Information, Messages, Music, Voice, Video, images modulate onto a carrier(s) of very high frequency
- Modulating signals are analog or digital.
- Digital are either 0 or 1 form, or symbols.
- Symbols are 2, 3, 4, 5 or 6 bit long

Modulation

- Modulation is a process of varying carrier parameters as a function of input analog or digital signals, due to voice, music or other information source
- Parameter are amplitude, frequency and phase angle (at t = integral multiple of time period)

Modulation

- Analog signal modulation
- Digital Modulation– Modulating bits (1 or 0), symbols (pair of bits 11, 10, 01, 00), triplet of bits 111, ….., 000, quadruplet of bits 1111, 0111, 0011,
- Modulation of signals before the medium access

Analog signals at any instant *t*

- Assume carrier signal $s_c(t) = s_{c0} \sin [2\pi f_c t + \phi_{c0}]$
- Amplitude modulation means carrier signal peak s_{c0} amplitude varying proportional to $s_m(t)$.
- Frequency modulation means carrier frequency f_c varying proportional to $s_m(t)$
- Phase modulation means carrier phase ϕ_{c0} varying proportional to $s_m(t)$

Digital signal at any instant *t* after modulation

- Voice converts to digital signals, of 1s and 0s.
- FSK (frequency shifted keying) means carrier signal frequency shifts to f_{c1} or f_{c0}, depending on signal 1 or 0, respectively.
- PSK (phase shifted keying) means carrier signal frequency phase shifts to $\phi_{c0} + \pi/2$ or $\phi_{c0} - \pi/2$ depending on signal 1 or 0, respectively.

QPSK (Quadrature Phase shifted keying)

- Two bits are grouped. S_0, S_1, S_2 and S_3 are four symbols—11, 01, 10 and 00. QPSK S_0, S_1, S_2 and S_3 phase angles are (i) $\varphi_c(t)$ is advanced by 45° ($\pi/4$ radian), (ii) reduced by 45° (= 315° = $7\pi/4$ radian), (iii) advanced by 135° ($3\pi/4$ radian) and (iv) reduced by 135° (= 225° = $5\pi/4$ radian), respectively .

QAM (Quadrature Amplitude Modulation)

- Transmits symbols S0, …,S63 where each symbol is a sequence of 6 bits. [$2^6 = 64$.]
- 64 Symbols are 111111, 011111, …, 000000.
- Three bits determine carrier quadrature and phase angle, and three determine the amplitude A1, A2 or A3
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QAM (Quadrature Amplitude Modulation)

- When the bits are transmitted after 64-QAM, the large spectrum bandwidth requirement reduces,

Modulation Methods

Figure 5.1

Summary

- AM, FM, PM
- FSK, PSK
- QPSK
- QAM

End of Lesson 01
Modulation